The World Health Organization Fetal Growth Charts

Computation of fetal growth distribution quantiles

This document accompanies the coefficients of the polynomials representing quantiles of the distributions of several fetal parameters, as a function of t, the gestational age. The coefficients tables are presented in a revised version, dated of March 13, 2023. The coefficients are the same used in the WHO Fetal Growth Calculator: https://srhr.org/fetalgrowthcalculator/#/

The fetal growth distributions by time are computed by quantile regression, for each quantile in the set {0.01, 0.025, 0.05, 0.10, 0.25, 0.50, 0.75, 0.90, 0.95, 0.975, 0.99} and for each fetal dimension. Details on the fittings and detailed information can be found in the reference Kiserud et al [1]. A necessary note: the WHO Fetal Growth Calculator does not show the 0.01 and 0.99 quantiles. The authors considered the statistical precision of the estimates too low. The coefficients in the coefficients tables include the extreme quantiles yielding to requests and so that they are computed from a single source of data and program

The fetal dimensions are:

- AC: abdominal circumference
- BPD: biparietal diameter (outer-inner)
- EFW: estimated fetal weight (Hadlock III estimation)
- FL: femur length
- HC: head circumference
- HL: humerus length

The curves are polynomials of degree up to 4, on the natural log scale. The polynomials can be represented by:

$$\log_e(y) = b_0 + b_1 t + b_2 t^2 + b_3 t^3 + b_4 t^4$$

where y is one of the fetal dimensions and *t* is the gestational time in weeks. (Note that *t* is continuous and any fraction of *t* can be used. The time *t* must be between 14 and 40 weeks). The estimated values on the raw scale are, naturally, $y = e^{\log_e(y)}$.

The coefficients are presented in scientific notation with 15 digits. It is recommended to use the coefficients in full precision in the calculation of the polynomials. In the cases that the polynomials are of degree 3, the coefficients b_4 are zero.

The coefficients files are in csv format (comma separated value). The first line contains the column (field) names, separated by commas. The remaining lines contain the respective identifiers and the coefficients, also separated by commas.

There are two files: coefficientsGlobalV3.csv and coefficientsEFWbySexV3.csv. The first file contains the
coefficients for computing the quantiles for all the fetal dimensions (including EFW), regardless of sex. The second file holds the coefficients for EFW by sex.

Notes

1. Extrapolations

We do not recommend extrapolations. The polynomials should be computed for $14 \leq t \leq 40$. Any value of t in this continuous interval will yield a valid result.

2. Interpolation of the quantiles

Simple linear interpolation provides a reasonable approximation for a quantile not in the list, from the minimum 0.01 to the maximum 0.99. It is better to do the interpolation on the log scale, which was used for the fitting, reverting the final result to the original scale. Say, for the α quantile, such that $\alpha_0 < \alpha < \alpha_1$ (the two neighboring tabled quantiles), first interpolate the log of the quantile

$$\log(y_\alpha) = \frac{\log(y_{\alpha_1}) - \log(y_{\alpha_0})}{\alpha_1 - \alpha_0}(\alpha - \alpha_0) + \log(y_{\alpha_0})$$

and finally, compute the interpolated value on the raw scale as y = $e^{\log_e(y)}$.

3. Extreme quantiles

Estimates for fetal dimensions for extreme quantiles (0.01, 0.025, 0.975, 0.99) must be interpreted with caution because the precision is low due to the smaller number of observations, especially when subdivided by sex, such as for EFW.

Reference

1. Kiserud T. et al.. The World Health Organization Fetal Growth Charts: A Multinational Longitudinal Study of Ultrasound Biometric Measurements and Estimated Fetal Weight. **PLOS Medicine 2017** Jan 24;14(1):e1002220. doi: 10.1371/journal.pmed.1002220. Erratum in: PLoS Med. 2017 Mar 24;14 (3):e1002284.